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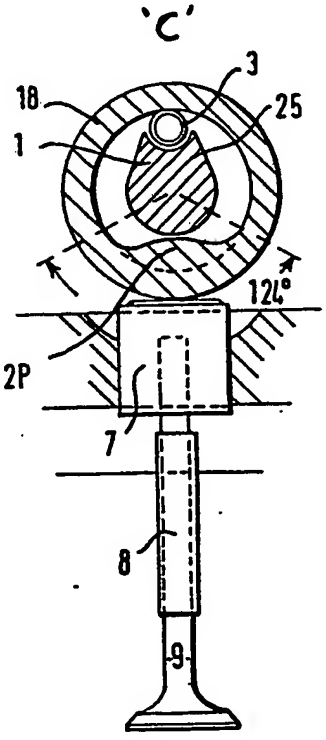
(54) Arrangements for converting rotary motion to linear motion

(57) An arrangement for converting rotary motion of a camshaft (1) to linear motion of a reciprocable valve (9) employs a follower (25) which is rotatable with the camshaft about its axis of rotation within a hollow cam (18) having an internal cam profile (2P). The cam profile of the cam is held in engagement with a roller (3) carried by the follower and the valve is held in engagement with the cam, so that on rotation of the camshaft a linear motion is imparted to the valve either as a result of displacement of the cam transversely of the axis of rotation or as a result of displacement of the axis of rotation in the direction of movement of the valve.



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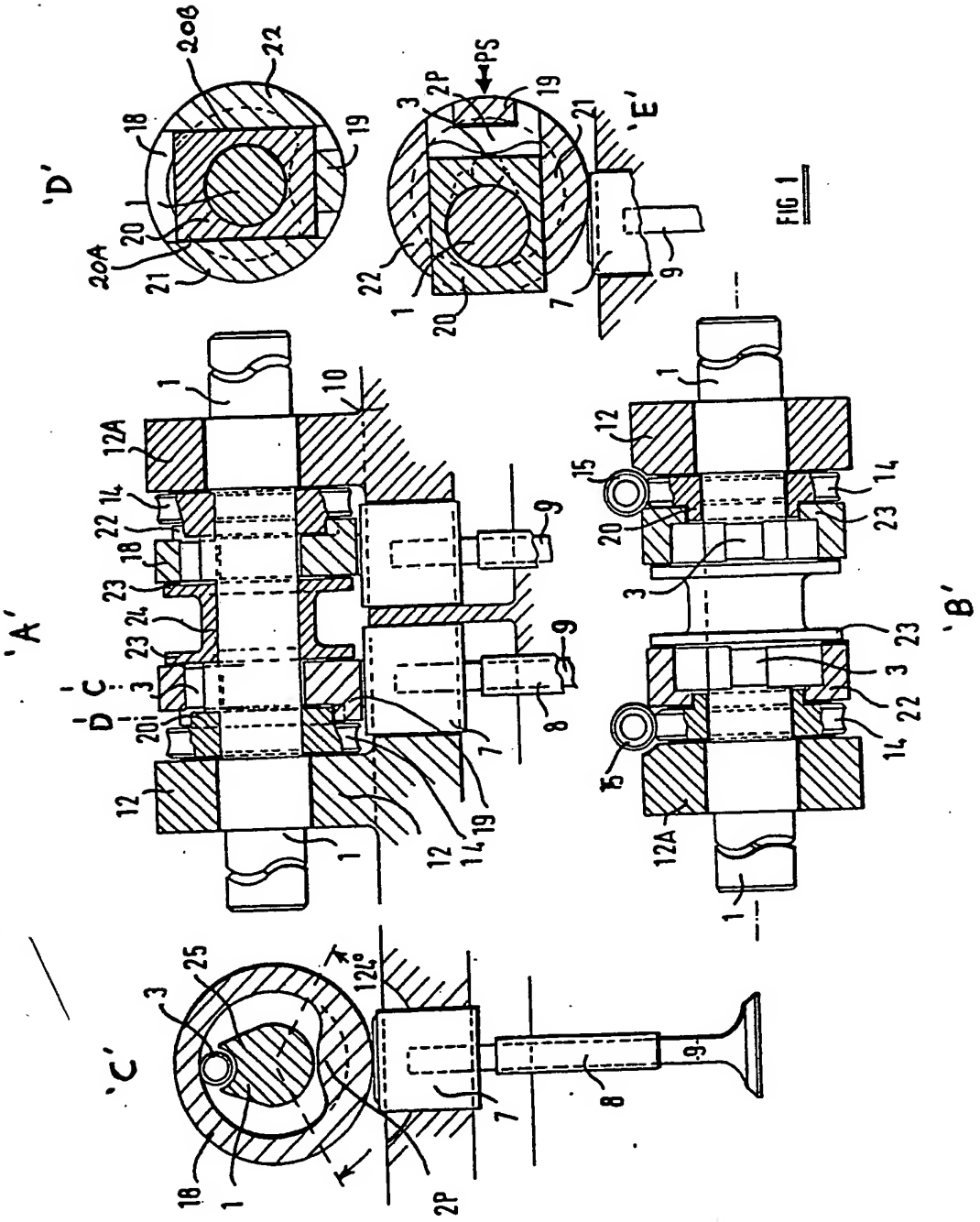

FIG 1

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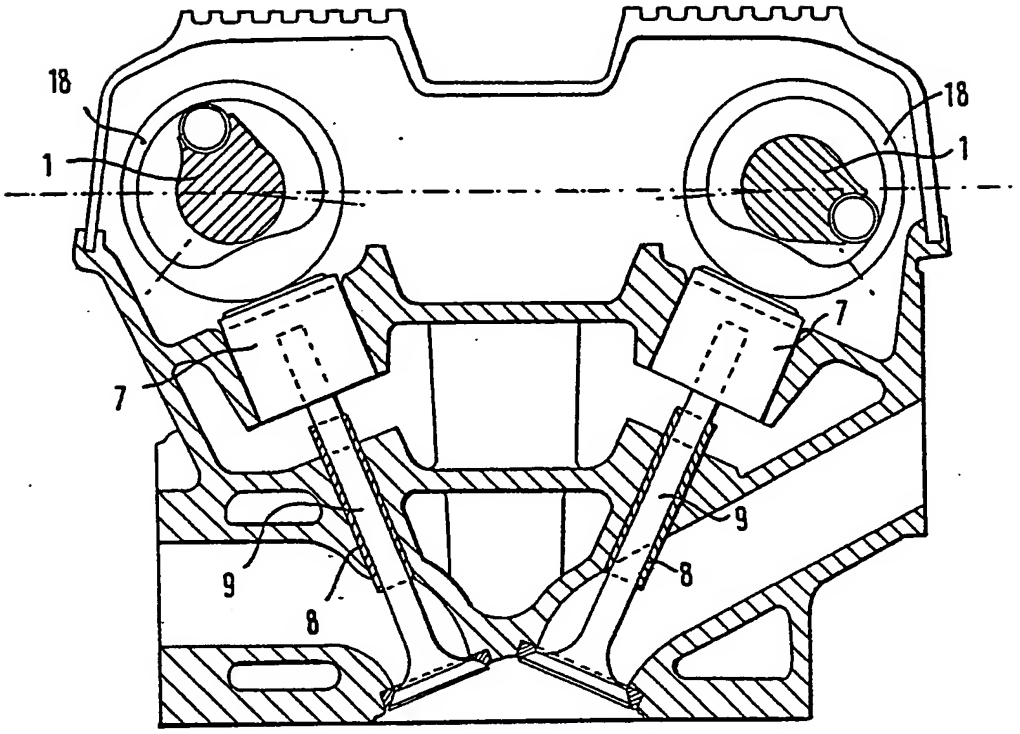

FIG. 3

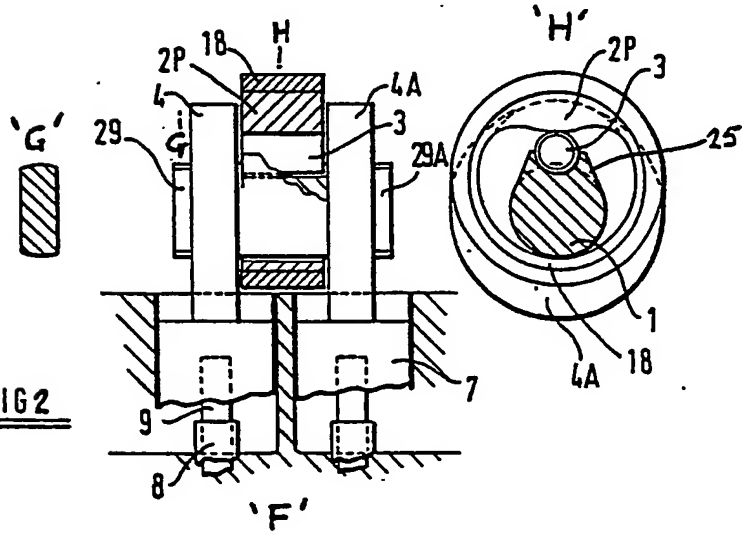

FIG 2

PATENTS ACT 1977
Q3751GB/ALM/mkf

Description of Invention

"Arrangements for converting rotary motion to linear motion"

THIS INVENTION relates to an arrangement for converting rotary motion to linear motion, which arrangement finds application in converting the rotary motion of a camshaft into linear motion of a reciprocable valve.

It is envisaged that the present invention will find particular application in internal combustion engines, in which environment it enables the timing and profile of a cam event to be varied.

According to the present invention, there is provided an arrangement for converting rotary motion of a first rotatable member to linear motion of a second linearly movable member, in which a follower member is rotatable with the first member about its axis of rotation within a hollow cam member having an internal cam profile, the cam profile of the cam member is held in engagement with the follower member and the second member is held in engagement with the cam member, so that on rotation of the first member the cam member imparts a linear motion to the second member.

In order that the invention may be more readily understood, embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a first poppet valve arrangement embodying the invention by means of five

views A to E, view A being a longitudinal section through the arrangement, view B being a plan view of the arrangement, view C being a cross-sectional view on the line C of view A, and views D and E being cross-sectional views on the line D of view A with a cam of the arrangement in two different positions;

Figure 2 illustrates a second embodiment of the invention by means of three views F, G and H, view F being a partially sectioned front elevation and views G and H being cross-sectional views on the respective lines G and H in view F; and

Figure 3 is a cross-sectional view through a cylinder head of an engine incorporating a valve operating arrangement embodying the present invention.

Referring firstly to Figure 1, a first arrangement embodying the invention for converting rotary motion to linear motion comprises a camshaft 1 which is rotatable to cause linear displacement of conventional poppet valves 9 each guided for linear movement in a valve guide 8 and provided with a valve bucket 7 which is biased upwardly in view A by a valve return spring (not shown) in order to hold the valve 9 in a normally closed position. View A shows a portion of the camshaft 1 rotatably supported by bearing members 12, 12A formed on the cylinder head 10 and serving to operate a pair of valves 9.

The portion of the camshaft between bearing members 12 and 12A is formed integrally with a pair of followers 25 each carrying a roller 3. Each of the followers 25 is disposed within a hollow cam 18 which is axially located on the camshaft 1 between a respective flange 23 of a spool-like central spacer 24 and a worm-wheel 14 received on the camshaft 1. The central spacer 24 may be freely

rotatable on the camshaft 1 or may be fixed to the camshaft. The camshaft 1 extends rotatably through the worm-wheel 14, the position of which about the axis of rotation of the camshaft is adjustable by means of a worm 15 (view B) engaged with the worm-wheel. The angle of engagement between the teeth on the worm-wheel and the worm is a locking angle of about 10 degrees such that the worm-wheel may be rotated by rotation of the worm but the worm cannot be rotated by the worm-wheel. If desired, the two cams 18 could be coupled together for operation byu a single worm drive.

The worm-wheel 14 has an axially extending projection 20 having a rectangular cross-section with parallel bearing surfaces 20A and 20B slidably engaging corresponding guide surfaces defined on the cam 18 by axial projections 21 and 22. The cam 18 is thus mounted for sliding movement transversely of the axis of rotation of the camshaft 1, whilst having its angular position about the axis of rotation adjustable by means of the worm and worm-wheel arrangement 14, 15.

The hollow cam 18 has a circular outer surface and an internal cam profile which exhibits a lobe 2P extending over substantially 124° of the rotation of the camshaft 1. The valve bucket 7 is held in engagement with the circular outer surface of the cam 18 as a result of the action of the valve spring (not shown). Similarly, the roller 3 carried by the follower 25 is held in engagement with the internal profile of the cam 18. A stop 19 formed on the cam 18 engages the projection 20 on the worm-wheel 14 to limit the upward movement of the cam and a cushion spring (not shown) may be provided to act between the stop 19 and the projection 20.

In use, the camshaft 1 is rotated about its axis,

resulting in rotation of the follower 25 within the hollow cam 18. When the roller 3 travelling on the internal cam profile comes into contact with the lobe 2P in the course of this rotation, the cam 18 is forced to slide on the projection 20 transversely of the axis of rotation, thereby applying pressure to the valve bucket 7, causing the valve 9 to move into an open position against the force of the valve spring.

Views C and D in Figure 1 show the cam in a first angular position relative to the axis of rotation of the camshaft 1, in which position the cam lobe is positioned centrally below the axis of rotation of the camshaft. This position of the cam 18 results in maximum displacement of the valve 9 upon rotation of the camshaft 1.

The angular position of the cam 18 is, however, adjustable about the axis of rotation of the camshaft by means of the worm drive 14, 15 and view E shows a second angular position in which the lobe 2P is positioned laterally of the axis of rotation of the camshaft 1, so that the movement of the cam 18 resulting from rotation of the follower 25 is transverse to the direction of movement of the valve 9 and thereby imparts no movement to the valve 9 during rotation of the camshaft 1. The arrow PS indicates a possible pressure spring which is mounted on the cylinder head in order to restrain the movement of the cam 18 and provide some lateral control. This spring may be applied to any point of the outer surface of the cam to prevent the cam from being subjected to hammering.

The second embodiment of the invention shown in Figure 2 comprises a fixed annular or hollow cam 18 having an internal cam profile with a lobe 2P. Camshaft 1 extends through the cam 18 and is formed integrally

with a follower 25 carrying a roller 3 engaged with the internal profile of cam 18.

The camshaft 1 is also formed with a pair of circular output rings 4, 4A on respective sides of the cam 18, which output rings are formed with square section projections 29 adapted to be engaged and driven by a suitable drive means (not shown) to rotate the camshaft 1 about its axis, whilst permitting displacement of such camshaft transversely of the axis of rotation. Upon rotation of the camshaft 1 by means of the drive projections 29, the entire assembly comprising the camshaft 1, output rings 4 and drive projections 29 reciprocates in the direction of movement of the valve 9, thereby applying force to the valve buckets 7 to displace the valves 9. The output rings 4, 4A are of similar diameter to that of the hollow cam 18, thereby enabling the arrangement to be positioned clear above the valves 9 themselves without having to be accommodated between the adjacent valves and enabling a compact structure to be achieved.

Figure 3 is a typical cylinder head cross-section illustrating how a valve operating arrangement embodying the invention might be accommodated in an internal combustion engine having four valves per cylinder.

CLAIMS:

1. An arrangement for converting rotary motion of a first rotatable member to linear motion of a second linearly movable member, in which a follower member is rotatable with the first member about its axis of rotation within a hollow cam member having an internal cam profile, the cam profile of the cam member is held in engagement with the follower member and the second member is held in engagement with the cam member, so that upon rotation of the first member the cam member imparts a linear motion to the second member.

2. An arrangement according to claim 1, in which the follower member carries a roller which engages the cam profile of the cam member.

3. An arrangement according to claim 1 or 2, in which resilient means acting on the second member holds the second member and the cam member in engagement.

4. An arrangement according to any one of claims 1 to 3, in which the cam member is displaceable transversely of the axis of rotation of the first member in order to impart linear motion to the second member.

5. An arrangement according to any one of claims 1 to 3, in which the first member is displaceable transversely of the axis of rotation thereof in order to impart linear motion to the second member.

6. An arrangement according to any one of claims 1 to 5, in which the first member is a camshaft and the second member is a valve to be actuated by the camshaft.

7. An arrangement for converting rotary motion of a

first rotatable member into linear motion of the second linearly movable member, substantially as hereinbefore described with reference to the accompanying drawings.

8. An internal combustion engine including an arrangement according to any one of the preceding claims.

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